CRWMS/M&O

Calculation Cover Sheet

Complete only applicable items.

1. QA: ~~QA~~ CMM 08-12-1999

MOL.19990812.0353

2. Calculation Title RIP Input Tables From WAPDEG For LA Design Selection: Continuous Post-Closure Ventilation Design - Open Loop			
3. Document Identifier (including Revision Number) B00000000-01717-0210-00065 REV 00			4. Total Pages 17
5. Total Attachments N/A	6. Attachment Numbers - Number of pages in each		
	Print Name	Signature	Date
7. Originator	Kevin G. Mon	Kevin Mon	7/19/99
8. Checker	Peter K. Mast	[signature] for P.K. Mast	7/19/99
9. Lead Design Engineer	Joon H. Lee	Joonhyoun Lee	July 21, 1999

10. Remarks

Input thermal hydrologic history files (DTN: MO9904MWDTHM57.000).
Computer software (WAPDEG version 3.09 and Post308) tracked by TBV-568.

Uses DTN: MO9807MWDWAPDG.000 on conceptual model.
Uses DTN: MO9810SPA00013.000 on input assumptions and input data.
Supporting Electronic Media = ACC: MOL.19990528.0286, DTN: MO9904MWDWAP65.006.

For LA Design Selection.

Revision History

11. Revision No.	12. Date Approved	13. Description of Revision
00	7-21-99	Initial Issue.

CONTENTS

1.0 Purpose

The purpose of this calculation is to document 1) the Waste Package Degradation (WAPDEG) version 3.09 (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*) simulations used to analyze waste package degradation and failure under the repository exposure conditions characterized by the open loop option of the post-closure ventilation design and, 2) post-processing of these results into tables of waste package degradation time histories suitable for use as input into the Integrated Probabilistic Simulator for Environmental Systems version 5.19.01 (RIP) computer program (Golder Associates 1998). Specifically, the WAPDEG simulations discussed in this calculation correspond to waste package emplacement conditions (repository environment and design) defined in the Total System Performance Assessment - Viability Assessment (TSPA-VA), with the exception that the open loop option of the post-closure ventilation License Application Design Selection (LADS) Design Alternative (Design Alternative 3b) was analyzed.

The open loop post-closure ventilation design alternative, under which airways to the surface remain open after repository closure, could result in substantial cooling and drying of the potential repository. In open loop post-closure ventilation, expanded air heated by waste decay would move up an exhaust shaft, pulling denser, cooler air into the repository through intake shafts. The exchange of air with the atmosphere could remove more heat and moisture.

As a result of the enhanced ventilation relative to the TSPA-VA base-case design, different temperature and relative humidity time histories at the waste package surface are calculated (input to the WAPDEG simulations), and consequently different waste package failure histories (as calculated by WAPDEG) result.

2.0 Method

Based on user-supplied input, the stochastic simulation code WAPDEG (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*) is used to generate waste package failure profiles. WAPDEG's inputs include time-varying histories of the temperature and relative humidity at the waste package surface (as discussed above), various temperature and relative humidity thresholds for corrosion initiation, corrosion models, and corrosion model parameter distributions. A waste package may fail either through localized corrosion processes (pitting or crevice corrosion), leading to small pinhole perforations, or through general corrosion processes leading to much larger "patch" perforations. More detailed discussions of the WAPDEG conceptual model are given elsewhere (CRWMS M&O 1998a. *Total System Performance Assessment-Viability Assessment (TSPA-VA) Analyses Technical Basis Document - Chapter 5, Waste Package Degradation Modeling And Abstraction,* pp. 5-27 to 5-29) (DTN: MO9807MWDWAPDG.000). The waste package failure profiles calculated by WAPDEG consist of time-varying measures of the number of pit and patch penetrations on each waste package. The WAPDEG post-processor, Post308 (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09),* Appendix D), abstracts this information to produce one RIP input table (Golder Associates 1998, pp. 7-22 through 7-25) per WAPDEG simulation. The RIP input table contains:

1) The fraction of waste packages failed versus time curve for the simulation,
2) The average number of pit penetrations per failed waste package versus time curve and,
3) The average number of patch penetrations per failed waste package versus time curve.

Post308 has two main objectives:

a) It reformats the WAPDEG output to conform to the RIP input format and,
b) It decreases the number of points in each of the three curves discussed above to approximately 83 (or less depending on the data being processed) through a process of time averaging.

More detailed discussions of the WAPDEG version 3.09 and Post308 codes appear elsewhere (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*).

3.0 Assumptions

For the calculations involved in attaining a post processed table for input into RIP there are two steps to consider: 1) Execution of the WAPDEG code and; 2) Post processing of WAPDEG output for creation of tables for input to RIP. There are several assumptions necessary to consider for the WAPDEG simulations. The assumptions used to model waste package degradation in this calculation are identical to those used in the TSPA-VA REV 01 base case calculation (CRWMS M&O 1998d. *Creating Input Tables from WAPDEG for RIP*) (DTN: MO9810SPA00013.000). Although WAPDEG version 3.07 (CRWMS M&O 1998c. *Software Routine Report for WAPDEG (Version 3.07)*) was used in the TSPA-VA base case calculation and WAPDEG version 3.09 is used in the present calculation, the assumptions listed in the TSPA-VA REV 01 base case calculation are applicable to the present calculation as the additional features of WAPDEG version 3.09 relative to WAPDEG version 3.07 are not used in this calculation. No additional assumptions pertaining to the use of the WAPDEG code are made as a result of considering the open loop option of the continuous post-close ventilation design alternative. No additional assumptions pertaining to the use of the Post308 code are made as a result of considering the open loop option of the continuous post-close ventilation design mode.

4.0 Use of Computer Software

4.1. Software Approved for QA Work

No software approved to quality affecting work was used in this calculation.

4.2. Software Routines

The software used to perform the waste package degradation simulations was WAPDEG version 3.09 (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*) (TBV-568) and its post processor, Post308 (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*, Appendix D) (TBV-568). The following has been obtained from the Software Configuration Secretary (SCS) relative to this software routine:

Software Name:	WAPDEG
Software Version:	3.09
CSCI Identifier:	30048 V3.09
Document Identifier:	30048–2999, REV 02
Media Identifier:	30048–M04–001, REV 02
Software Change Request:	LSBR 177

This software was obtained in accordance with appropriate procedures. The WAPDEG simulations were executed on a DELL PowerEdge 2200 Workstation equipped with Dual (2) Pentium II 266 MHz processors (CRWMS M&O tag 112371) in the Windows NT 4.0 operating system. The post processing was accomplished on a DELL PowerEdge 2200 Workstation equipped with Dual (2) Pentium II 266 MHz processors (CRWMS M&O tag 112371) in the Windows NT 4.0 operating system.

WAPDEG version 3.09 is an appropriate tool for this application, because it was specifically designed to calculate waste package failure profiles in a manner consistent with the information requirements of the RIP code. Although there has been a Software Routine Report (SRR) prepared for version 3.09 of the WAPDEG code (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*), WAPDEG did not go through the complete verification and validation process required by QAP-SI-0 REV 04 when effective, so it is not to be considered qualified and has been designated "to be verified" (TBV-568). WAPDEG version 3.09 was used within the range of values tested and documented in its Software Routine Report (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*).

Post308 is an appropriate tool for this application, because it is able to read WAPDEG output files and post-process them to make tables for input into RIP. Although all of the documentation necessary to fully qualify the Post308 code has been included in the WAPDEG version 3.09 SRR (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*, Appendix D), since WAPDEG version 3.09 did not go through the complete verification and validation process required by QAP-SI-0 REV 04 when effective, Post308 is not to be considered qualified and has been designated "to be verified" (TBV-568). Post308 was used within the range of values tested and documented in its Software Routine Report (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*, Appendix D).

5.0 Calculation

5.1. Description

Files containing the thermal hydrologic time, temperature, and relative humidity (RH) history at the surface of waste packages in the center, edge, and middle zones of the repository relevant to this design alternative study were obtained (Dunlap 1999) (DTN: MO9904MWDTHM57.000) in three Excel workbooks representing the edge (85_openL_LTA.xls), middle (85_openL3_LTA.xls), and center (85_openL6_LTA.xls) zones of the potential repository. These workbooks are included in the electronic media supporting this calculation (CRWMS M&O 1998i. *Supporting Media for "RIP Input Tables From WAPDEG For LA Design Selection: Continuous Post-Closure Ventilation Design - Open Loop"*) (DTN: MO9904MWDWAP65.006). The Excel workbooks are composed of worksheets containing the raw thermal hydrologic history files input to WAPDEG (these are labeled cf1s, cf2s, cf3s, cf4s, cf5s, cf6s, df1s, or df2s (cf for commercial spent nuclear fuel and df for defense high-level nuclear waste)), two worksheets containing graphs of these thermal hydrologic history files (these are labeled Tchart (the temperature histories) and RHchart (the relative humidity histories)), and other worksheets which are not relevant to this discussion. For each zone of the repository, there were six types of commercial spent nuclear fuel and two types of defense high-level waste packages considered. Each worksheet starts with 14 rows of cells that contain a unique header describing the case for which the data is provided. This is followed by rows containing columns of ASCII numerical data. Column 1 contains the time (years), Column 2 the waste package surface temperature (°C), Column 3 the relative humidity at the waste package surface (fraction), Column 4 the liquid saturation of the invert (fraction), and Columns 5, 6 and 7 are composed of zeros. The data in each worksheet containing the raw thermal hydrologic history input for WAPDEG was nearly identical for each of the eight waste types in each repository zone (as evidenced by the contents of the Tchart and RHchart worksheets). Thus, only the contents of the worksheet labeled cf1 (for each workbook (repository zone)) were saved as an individual ASCII text file for use in the WAPDEG simulations. This file was named consistently with the workbook file name prefix, worksheet name, and a repository zone abbreviation (EZ for edge zone, MZ for middle zone, and CZ for center zone) (i.e., 85_openL_LTAcf1sEZ.hst, 85_openL3_LTAcf1sMZ.hst, 85_openL6_LTAcf1sCZ.hst).

WAPDEG version 3.09 requires several input files (*.inp, *.cdf, and *.hst files, see below) (DTN: MO9904MWDWAP65.006) and creates several output files (*.aux, *.bin, *.cam, *.crm, *.out, *.pat) (DTN: MO9904MWDWAP65.006). Post308 reads from the *.bin, *.pat, *.out files of the WAPDEG version 3.09 runs and creates several output files (*.asc, *.dat, *.rip) (DTN: MO9904MWDWAP65.006). The *.rip files can be used as input to RIP and are described in Section 6.0.

Analyzing waste package failure histories with the WAPDEG code and creating the associated RIP input tables requires the use of a number of files for the WAPDEG code to read. The following are the files required for WAPDEG:

1) Files containing the relative humidity (RH) and temperature histories at the surface of waste packages (the *.hst files discussed above) (DTN: MO9904MWDWAP65.006).
2) Cumulative distribution function (cdf) for the temperature threshold for the onset of carbon steel corrosion. This threshold is used for the outer barrier or corrosion allowance material (CAM) (file: TThresh.cdf) (CRWMS M&O 1998e. *Cumulative Distribution Functions for the Temperature Threshold for the Onset of Carbon Steel Corrosion*) (DTN: MO9810SPA00013.000).
3) One cdf each for the RH threshold for the onset of humid-air corrosion (file: HARH.cdf) and the transition from humid-air corrosion to aqueous corrosion for the CAM outer barrier (file: AQRH.cdf) (CRWMS M&O 1998f. *Cumulative Distribution Functions for the Relative Humidity Thresholds for the Onset of Carbon Steel Corrosion*) (DTN: MO9810SPA00013.000).
4) Cumulative distribution functions for the CRM general corrosion rates with no drips at 25, 50, and 100°C (files: gnd17550.cdf, gnd27550.cdf, gnd37550.cdf) (CRWMS M&O 1998g. *Cumulative Distribution Functions for No Drip Corrosion Resistant Material General Corrosion Model*) (DTN: MO9810SPA00013.000).
5) Cumulative distribution functions for general corrosion rates under dripping for the inner barrier corrosion resistant material (CRM) at 25, 50, and 100°C (files: g8415050.cdf, g8425050.cdf, g8435050.cdf) (CRWMS M&O 1998h. *Cumulative Distribution Functions for the Dripping Case of the Corrosion Resistant Material General Corrosion Model*) (DTN: MO9810SPA00013.000).
6) The above file names and other model parameters are contained in the WAPDEG input file (*.inp) for the particular simulation being executed. With the exception of the thermal hydrologic time, temperature, and relative humidity history files discussed in 1) above, the other parameters in the WAPDEG input file are identical to those discussed in the TSPA-VA REV 01 base case calculation (CRWMS M&O 1998d. *Creating Input Tables from WAPDEG for RIP*, Section 5.0) (DTN: MO9810SPA00013.000).

The input files discussed above are used by WAPDEG to produce waste package degradation profiles. The waste package degradation profiles resulting from a WAPDEG simulation are then read by the post processor, Post308, which generates a table in a format appropriate for input into RIP (Golder Associates 1998, pp. 7-22 through 7-25). The RIP input table contains:

1) The fraction of waste packages failed versus time curve for the simulation,
2) The average number of pit penetrations per failed waste package versus time curve and,
3) The average number of patch penetrations per failed waste package versus time curve.

5.1.1. WAPDEG Input Files and Parameters Used

Six WAPDEG input files were used to generate the RIP input tables for the License Application Design Selection analysis of the open loop option of the post-closure ventilation design alternative:

NE1a5s5a3bCZ.inp, NE1a5s5a3bEZ.inp, NE1a5s5a3bMZ.inp, NE0a5s6a3bCZ.inp, NE0a5s6a3bEZ.inp, and NE0a5s6a3bMZ.inp. These input files are included in the electronic media supporting this calculation (CRWMS M&O 1998i. *Supporting Media for "RIP Input Tables From WAPDEG For LA Design Selection: Continuous Post-Closure Ventilation Design - Open Loop"*) (DTN: MO9904MWDWAP65.006).

The first two characters of the input file name have no significance to this analyses. The next character (0 or 1) indicates respectively that a no-drip case is being simulated or that 100% of the waste package surface is subjected to dripping throughout the simulation. The next two characters (a5) indicate that the file is for the base case infiltration. The next two characters (s5 or s6) refer to the different uncertainty/variability splits and percentiles of the uncertainty distribution used for the median of the CRM general corrosion rate variability distributions. The classifications are as follows:

Uncertainty/Variability Splitting
(0.25 Uncertainty = 0.75 Variability, etc.)

		Uncertainty		
		0.25	0.50	0.75
Percentile	5th	s1	s2	s3
	50th	s4	s5	s6
	95th	s7	s8	s9

From the above table, it is apparent that the input files (NE1**a5s5**a3bCZ.inp, NE1**a5s5**a3bEZ.inp, and NE1**a5s5**a3bMZ.inp) use a 50% uncertainty - 50% variability split and use the 50th percentile of the uncertainty distribution for the median of the CRM general corrosion rate variability distributions and that the input files (NE0**a5s6**a3bCZ.inp, NE0**a5s6**a3bEZ.inp, and NE0**a5s6**a3bMZ.inp) use a 75% uncertainty - 25% variability split and use the 50th percentile of the uncertainty distribution for the median of the CRM general corrosion rate variability distributions. The next three characters in the input file name (a3b) indicate that these input files pertain to alternative 3b of the LADS study. The last characters in the input file name are either CZ for the center zone, EZ for the edge zone, or MZ for the middle zone of the potential repository. For illustration, the input file NE1a5s5a3bCZ.inp is shown below:

```
NE1a5s5a3bCZ.inp

snf, always drip, 100%, No Backfill, lta nominal i alpha mean, 1/6/99
Uncertainty/Variability=50/50 drip, 50th Quantile

START OF PARAMETERS
3.09                          |Version number of code
1                             |Number of alternate histories
85_openL6_LTAcf1sCZ.hst       |History file
400, 0., 0.                   |# packages/group and Temp & RH std deviations
10.0, 2.0                     |Thickness of outer, inner barriers (cm)
75., 0.35                     |% thick to fail CRM, frac variance to packs
400, 964, 3100, 3100          |Number of packs, patches/pack, pits/patch
1.0, 1.e6, 1200               |Bin start time & end time (y), and # of bins
1.e4, 5.e4, 1.e5, 1.e6        |Output times (y) for cumul. pit penetrations
304058394, F, F               |Random# seed, restart flag, ignore CAM variance
```

```
0.0, 0.0                        |Max temp, RH change over a time step (C, %RH)
180.0, 180.0                    |Angle defining top/bottom (degrees)
Fixed                           |Distribution for fraction top seeing drips
1.0                             |Distribution parameter(s)
Fixed                           |Distribution for fraction bottom seeing drips
1.0                             |Distribution parameter(s)
Fixed                           |Distribution for dripping start time
0.0                             |Distribution parameter(s)
Fixed                           |Distribution for dripping stop time
1000000.0                       |Distribution parameter(s)
T, F                            |Neutral(T/F) water initially, new water (T/F)
Fixed                           |Distr for time range for ceramic protection
0.0                             |Distribution parameter(s)
1.0                             |Package variance share
[No Drip Model, CAM]            |This segment always required
CAMGeneral+PitMultiples         |CAM corrosion model for no drips
B-Normal                        |Distribution for pit multiple
1.5, 0.25, 1.0, 1.0e6           |Mean, StDev, Min, Max
[No Drip Model, CRM]            |This segment always required
CRMGeneralRateOnly              |CRM corrosion model for drips
3, 1.e+6                        |Number of dists (temps °C), max CRM rate
25.0                            |Temp appropriate for dist #1
File                            |Distribution type for #1
gnd17550.cdf                    |Distribution parameter (s)
50.0                            |Temp appropriate for dist #2
File                            |Distribution type for #2
gnd27550.cdf                    |Distribution parameter (mm/yr)
100.0                           |Temp appropriate for dist #3
File                            |Distribution type for #3
gnd37550.cdf                    |Distribution parameter (mm/yr)
[No Drip Features]              |This segment always required
File                            |Distr for thermal protection temperature
TThresh.cdf                     |Distribution parameter(s)
File                            |Dist type for humid-air initiation
HARH.cdf                        |Distribution parameter(s)
File                            |Dist type for humid-air/aqueous transition
AQRH.cdf                        |Distribution parameter(s)
1.0                             |RH correlation factor
0.0, 0.0                        |Galvanic protect depth %, % patches protected
0.0                             |Spalling depth as a % of thickness
Fixed                           |Dist for multiple for CAM corrosion rate
1.0                             |Distribution parameter(s)
Fixed                           |Dist for multiple for CRM corrosion rate
1.0                             |Distribution parameter(s)
1.0                             |Pack variance share for multiples
[Neutral Drip Model, CAM]       |Required if any non-neutral drips can be seen
CAMGeneral+PitMultiples         |CAM corrosion model for no drips
B-Normal                        |Distribution for pit multiple
1.5, 0.25, 1.0, 1.0e6           |Mean, StDev, Min, Max
[Neutral Drip Model, CRM]       |Required if any non-neutral drips can be seen
CRMGenrate+ArrheniusPit         |CRM corrosion model for drips
3, 1.e+6                        |Number of dists (temps), max CRM rate
25.0                            |Temp appropriate for dist #1
File                            |Distribution type for #1
g8415050.cdf                    |Distribution parameter (s)
50.0                            |Temp appropriate for dist #2
File                            |Distribution type for #2
g8425050.cdf                    |Distribution parameter (s)
100.0                           |Temp appropriate for dist #3
```

```
File                          |Distribution type for #3
g8435050.cdf                  |Distribution parameter (mm/yr)
Normal                        |Distribution type for A (b0)
11.275, 2.4495                |Distribution parameter(mm/yr)
Fixed                         |Distribution type for K (b1)
5.5494e+003                   |Distribution parameter(mm/yr)
Fixed                         |Distribution type for n
0.5                           |Distribution parameter(s)
[Neutral Drip Features]       |Required if any non-neutral drips can be seen
File                          |Distr for thermal protection temperature
TThresh.cdf                   |Distribution parameter(s)
Uniform                       |Dist type for CRM LC T init
80.0, 100.0                   |Distribution parameter
File                          |Dist type for humid-air initiation
HARH.cdf                      |Distribution parameter(s)
File                          |Dist type for humid-air/aqueous transition
AQRH.cdf                      |Distribution parameter(s)
1.0                           |RH correlation factor
0.0, 0.0                      |Galvanic protect depth %, % patches protected
0.0                           |Spalling depth as a % of thickness
Fixed                         |Dist for multiple for CAM corrosion rate
1.0                           |Distribution parameter(s)
Fixed                         |Dist for multiple for CRM corrosion rate
1.0                           |Distribution parameter(s)
1.0                           |Pack variance share for multiples
```

To gain a deeper understanding of the WAPDEG code, the interested reader is directed to the Software Routine Report for WAPDEG (CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*).

5.2. Procedure

WAPDEG was executed in a Windows NT 4.0 MS-DOS prompt window. WAPDEG prompts the user for the WAPDEG input file name (i.e., NE1a5s5a3bCZ.inp).

The "raw" output from a WAPDEG simulation consists of six files: a *.out file, *.pat file, *.bin file, *.crm file, *.cam file, and *.aux file (where "*" is the input file name prefix). The content and format of these files are discussed in the WAPDEG version 3.09 Software Routine Report (CRWMS M&O 1998b, Section 4.1). These files are also included in the electronic media supporting this calculation (CRWMS M&O 1998i. *Supporting Media for "RIP Input Tables From WAPDEG For LA Design Selection: Continuous Post-Closure Ventilation Design - Open Loop"*) (DTN: MO9904MWDWAP65.006). Only the *.out (waste package failure curves), *.pat (cumulative number of patch penetrations for each waste package), and *.bin (cumulative number of pit penetrations for each waste package) files are used by Post308 to create the RIP input tables.

In order to create the tables for input to RIP, Post308 is executed in a Windows NT 4.0 MS-DOS prompt window within the same directory as the output files from WAPDEG (i.e., *.bin, *.pat, *.out). The program prompts the user for the particular filename prefix that is common to the WAPDEG simulation output files to be post processed. After the program post processes the WAPDEG output, it prompts the user to enter a file name for the RIP input table to be created. The RIP input tables were chosen to have the same prefix name as the corresponding WAPDEG input files with a *.rip extension. The output from the post processor consists of three files; *.asc, *.dat, and *.rip. The content and format of these files are discussed in the WAPDEG version 3.09 Software Routine Report (CRWMS M&O 1998b, Appendix D). These files are also included in the electronic media supporting this calculation (CRWMS M&O 1998i. *Supporting Media for "RIP Input Tables From WAPDEG For LA Design Selection: Continuous Post-Closure Ventilation Design - Open Loop"*) (DTN: MO9904MWDWAP65.006).

6.0 Results

Since unqualified inputs were used in the development of the results presented in this section, they should be considered TBV. This document will not directly support any construction, fabrication, or procurement activity, and therefore, the inputs and outputs are not required to be procedurally controlled as TBV. However, any use of the data from this analysis for inputs into documents supporting construction, fabrication, or procurement is required to be controlled as TBV in accordance with appropriate procedures. Furthermore, this calculation makes use of software (WAPDEG version 3.09 and Post308) that are unqualified (TBV-568).

All input and output files relevant to this calculation are included in the electronic media supporting this calculation (CRWMS M&O 1998i. *Supporting Media for "RIP Input Tables From WAPDEG For LA Design Selection: Continuous Post-Closure Ventilation Design - Open Loop"*) (DTN: MO9904MWDWAP65.006). For brevity, only selected files are reproduced in hardcopy form within this section .

The primary outputs of the Post308 post processor are the RIP input tables. The RIP input tables are formatted as multidimensional lookup-tables as discussed in the RIP - Theory Manual and User's Guide (Golder Associates 1998, pp. 7-22 through 7-25).

For reference the RIP input table NE1a5s5a3bCZ.rip (DTN: MO9904MWDWAP65.006) is shown below.

```
! From wapdeg file: NE1a5s5a3bCZ
! From wapdeg version: 3.09
! Postprocessor: post308
! NE1a5s5a3bCZ.inp
!
! snf, always drip, 100%, No Backfill, lta nominal i alpha mean, 1/6/99
! Uncertainty/Variability=50/50 drip, 50th Quantile
!
! START OF PARAMETERS
 2
 3  82
 1   2   3
         0.0000
     16594.8691
     24081.2320
     35084.4864
     40335.7888
     45981.5858
     49848.3854
```

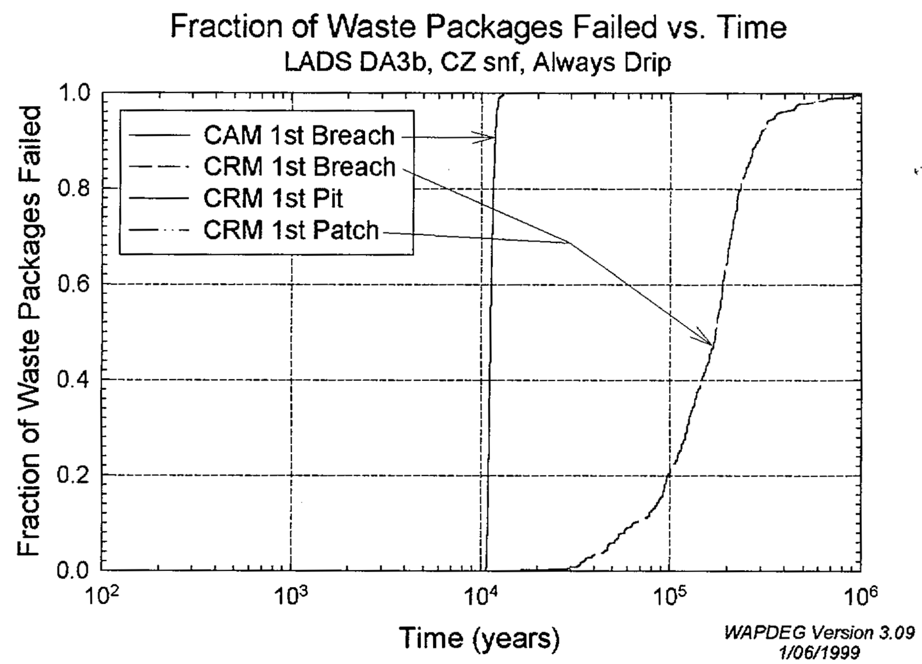
```
 53399.3508
 56900.3743
 62037.0440
 70464.0516
 78533.9720
 83672.7312
 88108.7800
 91735.1926
 94406.0876
 96052.1733
 98289.5158
101162.4149
105326.0936
109652.6642
112851.4635
115480.1118
118855.4739
121618.6001
123739.1691
126621.4246
128824.9552
131071.1759
134902.2484
138038.4265
139636.8361
143726.2112
147910.8388
150489.8452
154888.5050
159406.9292
163119.9935
165958.6907
169831.8686
173780.0829
175792.3614
177827.9410
179887.0915
181970.0859
184077.2001
186208.7137
188364.9089
190546.0718
192752.4913
194984.4600
197242.2736
199526.2315
201836.6364
204173.7945
206538.0156
208929.6131
211348.9040
213796.2090
216271.8524
218776.1624
221309.4710
225168.2723
229086.7653
231739.4650
234422.8815
```

238510.3312		
242661.0095		
248324.2817		
255568.4244		
263038.4205		
270711.8056		
275422.8703		
283488.8468		
295133.9620		
303743.6417		
316269.6828		
336964.3414		
363174.3124		
417532.7582		
542470.8677		
1000000.0000		
0.0000	0.0000	0.0000
0.0000	0.0000	0.0000
0.0049	0.0000	0.7956
0.0205	0.0000	1.2758
0.0333	0.0000	1.4097
0.0437	0.0000	1.7719
0.0592	0.0000	1.7622
0.0703	0.0000	1.8763
0.0809	0.0000	1.8312
0.0936	0.0000	1.9640
0.1066	0.0000	2.2544
0.1196	0.0000	2.4883
0.1338	0.0000	2.5577
0.1478	0.0000	2.7738
0.1596	0.0000	3.0074
0.1773	0.0000	3.0308
0.1865	0.0000	3.1426
0.1996	0.0000	3.2630
0.2083	0.0000	3.3959
0.2220	0.0000	3.6595
0.2344	0.0000	4.0578
0.2504	0.0000	4.3824
0.2594	0.0000	4.5979
0.2717	0.0000	4.7936
0.2871	0.0000	4.9109
0.2963	0.0000	5.0036
0.3136	0.0000	5.0854
0.3264	0.0000	5.2231
0.3368	0.0000	5.3259
0.3498	0.0000	5.6473
0.3637	0.0000	5.8971
0.3743	0.0000	5.9516
0.3832	0.0000	6.3415
0.3996	0.0000	6.7576
0.4100	0.0000	6.8929
0.4212	0.0000	7.2044
0.4346	0.0000	7.5869
0.4518	0.0000	7.7852
0.4633	0.0000	8.0026
0.4729	0.0000	8.4380
0.4872	0.0000	9.0151
0.5031	0.0000	9.1329
0.5196	0.0000	9.3683

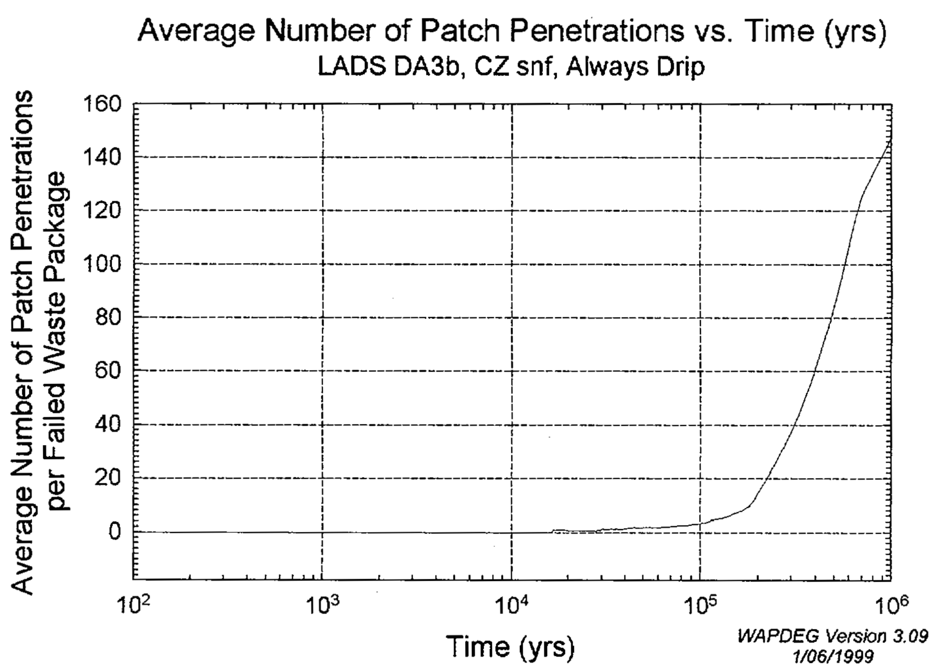
0.5379	0.0000	9.5280
0.5420	0.0000	10.1422
0.5533	0.0000	10.6276
0.5683	0.0000	10.9620
0.5792	0.0000	11.4470
0.5957	0.0000	11.8940
0.6137	0.0000	12.2980
0.6252	0.0000	12.8921
0.6364	0.0000	13.6463
0.6436	0.0000	14.3679
0.6608	0.0000	14.9103
0.6759	0.0000	15.4645
0.6860	0.0000	16.0127
0.6952	0.0000	16.7045
0.7051	0.0000	17.2570
0.7161	0.0000	17.8107
0.7342	0.0000	18.2441
0.7427	0.0000	18.9153
0.7511	0.0000	19.5470
0.7629	0.0000	20.5365
0.7908	0.0000	21.2008
0.7963	0.0000	21.9647
0.7987	0.0000	22.9078
0.8130	0.0000	23.8508
0.8256	0.0000	24.7467
0.8357	0.0000	26.1353
0.8485	0.0000	27.8799
0.8600	0.0000	29.6870
0.8762	0.0000	31.2022
0.8873	0.0000	32.0481
0.8944	0.0000	33.9912
0.9090	0.0000	36.6459
0.9225	0.0000	38.3886
0.9304	0.0000	41.4062
0.9452	0.0000	46.1412
0.9567	0.0000	52.2260
0.9651	0.0000	65.0403
0.9810	0.0000	93.8071
0.9975	0.0000	146.8872

The RIP input table consists of a column of times in years (the first single column of data) followed by three columns consisting of the fraction of waste packages failed, the number of pit penetrations per failed waste package, and the number of patch penetrations per failed waste package. These last three columns all share the same time grid (the first single column of data).

Presented below is a graph (derived from the NE1a5s5a3bCZ.dat file) of the first breach (patch or pit) curves of both the CAM (outer carbon steel) and CRM (inner Alloy 22) layers, and the first patch and first pit curves of the CRM inner layer for the center region dripping (NE1a5s5a3bCZ.inp) case:



As no localized corrosion is initiated in the center region dripping (NE1a5s5a3bCZ.inp) case, there is no CRM 1st Pit curve and the CRM 1st Breach and 1st Patch curves coincide. Below is shown a graph of the average number of failed patches per failed waste package (derived from the NE1a5s5a3bCZ.asc file):



The first breach curve for the CRM and the average number of patch penetrations per failed waste package curves are also represented in the RIP input table, NE1a5s5a3bCZ.rip.

7.0 References

CRWMS M&O 1998a. *Total System Performance Assessment-Viability Assessment (TSPA-VA) Analyses Technical Basis Document - Chapter 5, Waste Package Degradation Modeling And Abstraction*. B00000000-01717-4301-00005 REV 01. Las Vegas, Nevada CRWMS M&O. ACC: MOL.19981008.0005. DTN: MO9807MWDWAPDG.000.

CRWMS M&O 1998b. *Software Routine Report for WAPDEG (Version 3.09)*. CSCI: 30048 V3.09. DI: 30048-2999 REV 02. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981012.0224.

CRWMS M&O 1998c. *Software Routine Report for WAPDEG (Version 3.07)*. CSCI: 30048 V3.07. DI: 30048-2999 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980715.0166.

CRWMS M&O 1998d. *Creating Input Tables from WAPDEG for RIP*. B00000000-01717-0210-00013 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981110.0431. DTN: MO9810SPA00013.000.

CRWMS M&O 1998e. *Cumulative Distribution Functions for the Temperature Threshold for the Onset of Carbon Steel Corrosion*. B00000000-01717-0210-00015 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980603.0253. DTN: MO9810SPA00013.000.

CRWMS M&O 1998f. *Cumulative Distribution Functions for the Relative Humidity Thresholds for the Onset of Carbon Steel Corrosion*. B00000000-01717-0210-00016 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980603.0257. DTN: MO9810SPA00013.000.

CRWMS M&O 1998g. *Cumulative Distribution Functions for No Drip Corrosion Resistant Material General Corrosion Model*. B00000000-01717-0210-00012 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980715.0174. DTN: MO9810SPA00013.000.

CRWMS M&O 1998h. *Cumulative Distribution Functions for the Dripping Case of the Corrosion Resistant Material General Corrosion Model*. B00000000-01717-0210-00014 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19980831.0012. DTN: MO9810SPA00013.000.

CRWMS M&O 1998i. *Supporting Media for "RIP Input Tables From WAPDEG For LA Design Selection: Continuous Post-Closure Ventilation Design - Open Loop"*. 210-65r0.exe. Windows self-extracting archive. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990528.0286. DTN: MO9904MWDWAP65.006.

Dunlap, 1999. *Thermal-Hydrology Modeling of the Post-Closure Ventilation Alternative Design*. DTN: MO9904MWDTHM57.000. Las Vegas, Nevada: CRWMS M&O.

Golder Associates 1998. *RIP Integrated Probabilistic Simulator for Environmental Systems, Theory Manual and User's Guide*. Redmond, Washington: Golder Associates, Inc. TIC: 238560.

8.0 Attachments

N/A.